Thermalization model for isomeric alpha decay in the r-process

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Isomeric states of heavy nuclei play an important role in the rapid neutron capture (r-process) nucleosynthesis [1] which happens in extreme environments such as the ejecta following a binary neutron star merger. Alpha decays of isomeric states in these environments are expected to be sensitive to the ambient temperatures [2]. Such radioactive decays of the heavy elements power the kilonova light curves. Apart from this, alpha decay half-lives are also an essential input to the reaction networks that predict the abundance of heavy elements.

Alpha decay rates at elevated temperatures, calculated within the simplified assumption of thermal equilibrium between the ground and excited states (including isomeric states) display an enhancement of the decay rates with temperature [2]. Motivated by this finding, we have developed a model (based on the seminal work of Ward and Fowler [3]) for the temperature dependence of alpha-decay half-lives that explicitly takes the transitions from both excited levels and isomeric states into account. Temperature-dependent alpha decay rates calculated with the objective of integrating into the r-process nuclear network codes, will be presented.

References

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